

Manage Respiratory Trauma

Overview

- Terminology
- Anatomy
- Respiratory Trauma
- Chest Seals & Needle Thoracentesis

Learning Objectives

Please Read Your

Terminal Learning Objectives

And

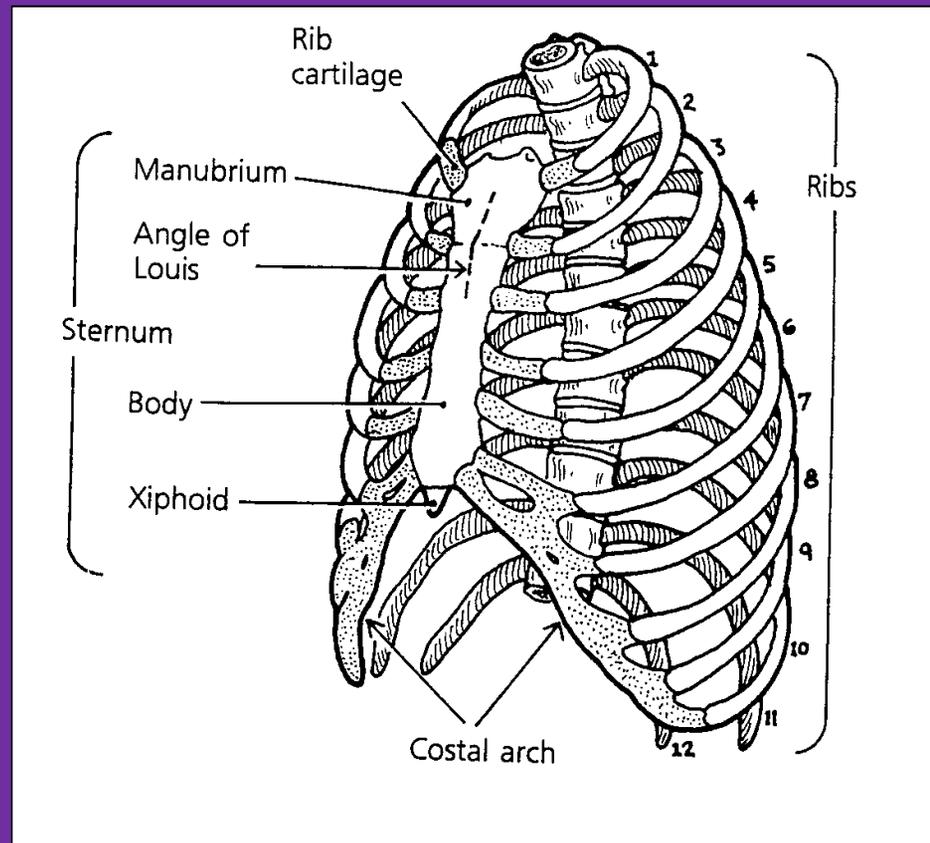
Enabling Learning Objectives



Anatomy

Thorax (Chest Cavity)

- Protected by a bony cage formed by the:
 - Sternum
 - Costal cartilages
 - Ribs
 - Vertebrae



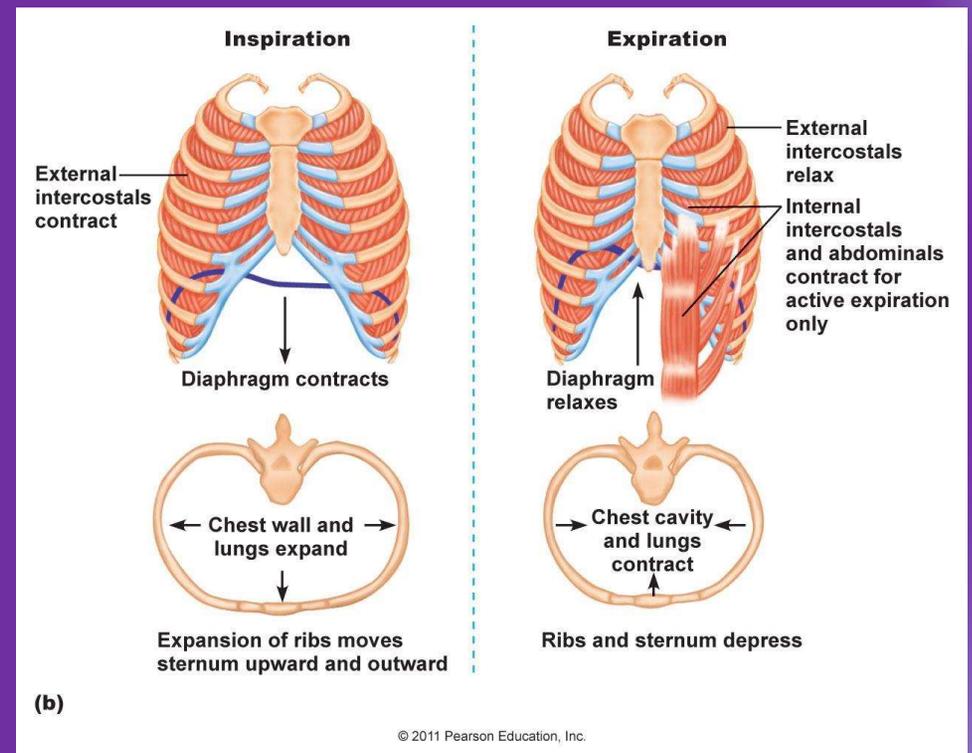
Anatomy

Diaphragm

- Primary muscle of respiration
- Inferior border of the chest cavity

Intercostal Muscles

- External intercostal muscles aid in quiet and forced inhalation
- Internal intercostal muscles aid in forced expiration (quiet expiration is a passive process)



Anatomy

Pleura

- Thin membranes separated by a small amount of fluid
- Fluid between the two pleural membranes create surface tension and causes the two pleura to stick together and prevents lungs from collapsing

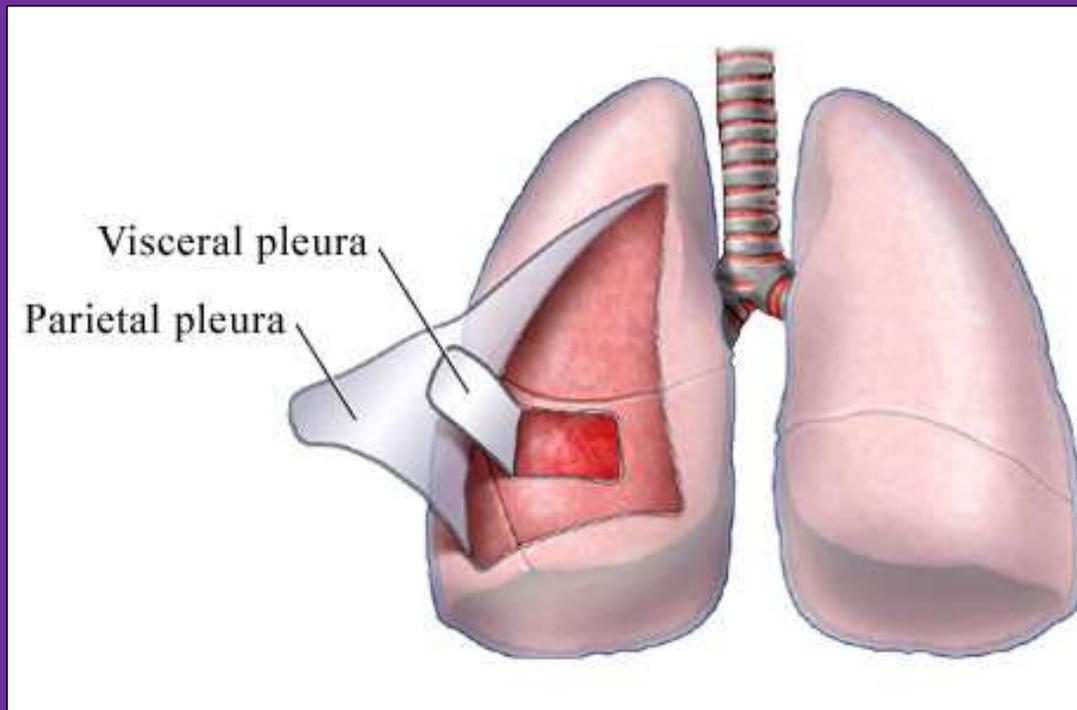
Parietal Pleura

- Lines inner portion of the thoracic cavity

Visceral Pleura

- Lines the outer surface of the lung

Anatomy



Anatomy

Lungs

- Occupy the left and right halves of the thoracic cavity
- Left lung: 2 lobes
- Right lung: 3 lobes, larger than the left

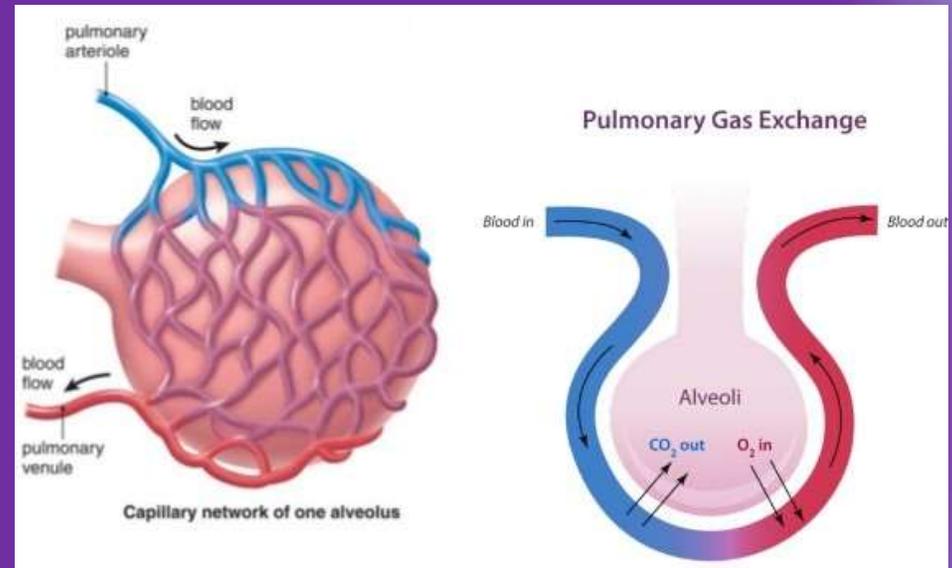
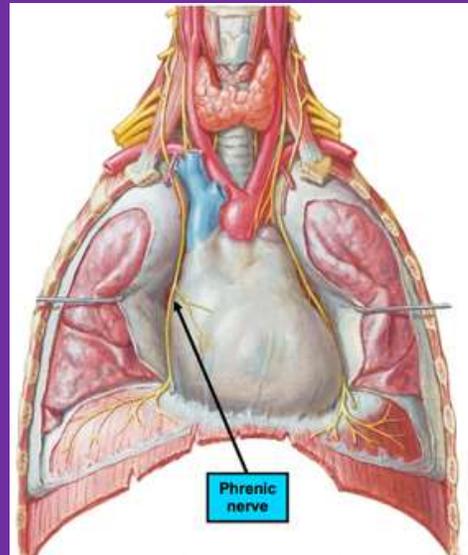
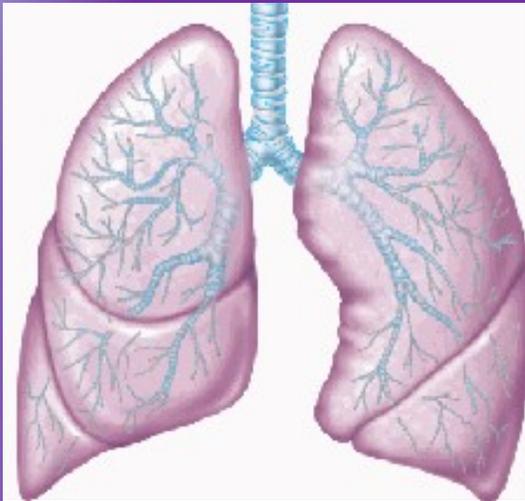
Alveoli

- Smallest component of the lungs, saclike structures where CO₂ and O₂ exchange takes place

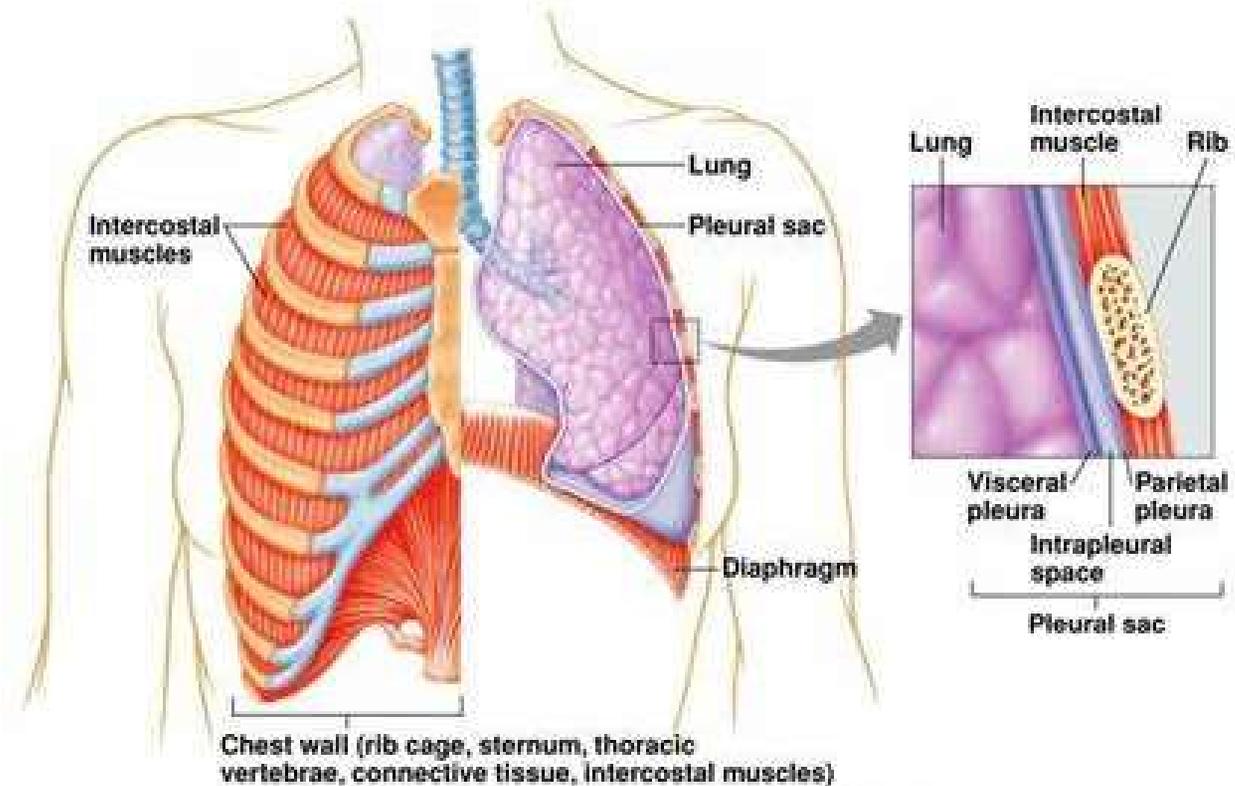
Mediastinum

- Contains the heart and its vessels, the esophagus, the trachea, the phrenic and cardiac nerves, the thoracic duct, the thymus, and the lymph nodes of the central chest.

Anatomy



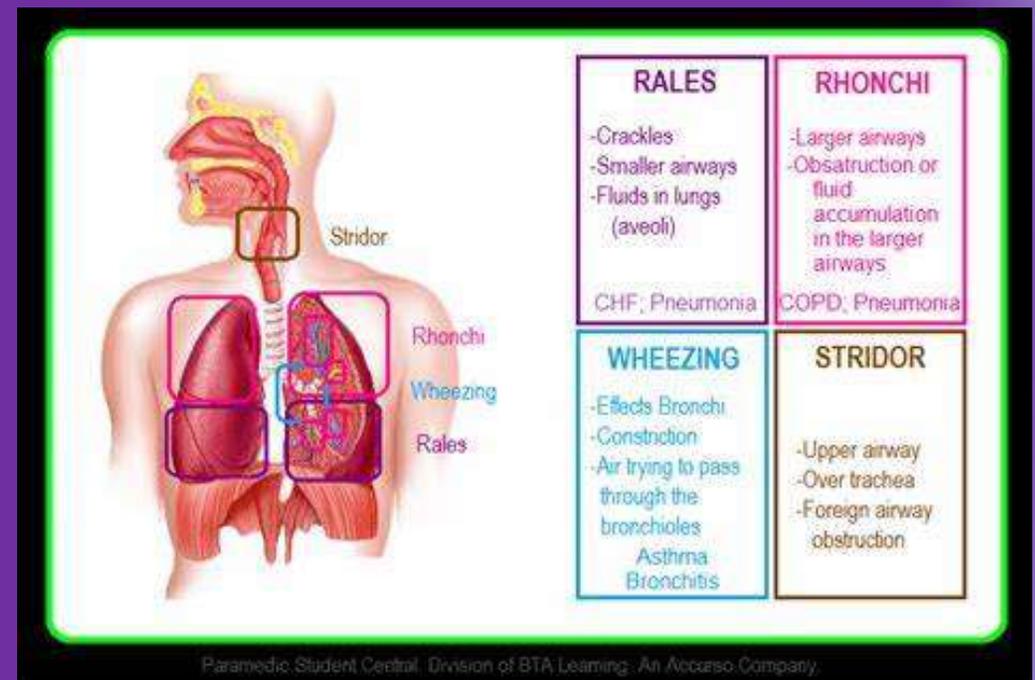
Anatomy





Terminology

- **Wheeze** - High pitched whistling sound that is caused by movement of air through a narrowed airway
- **Stridor** - A harsh shrill respiratory sound produced from the obstruction of the laryngeal area

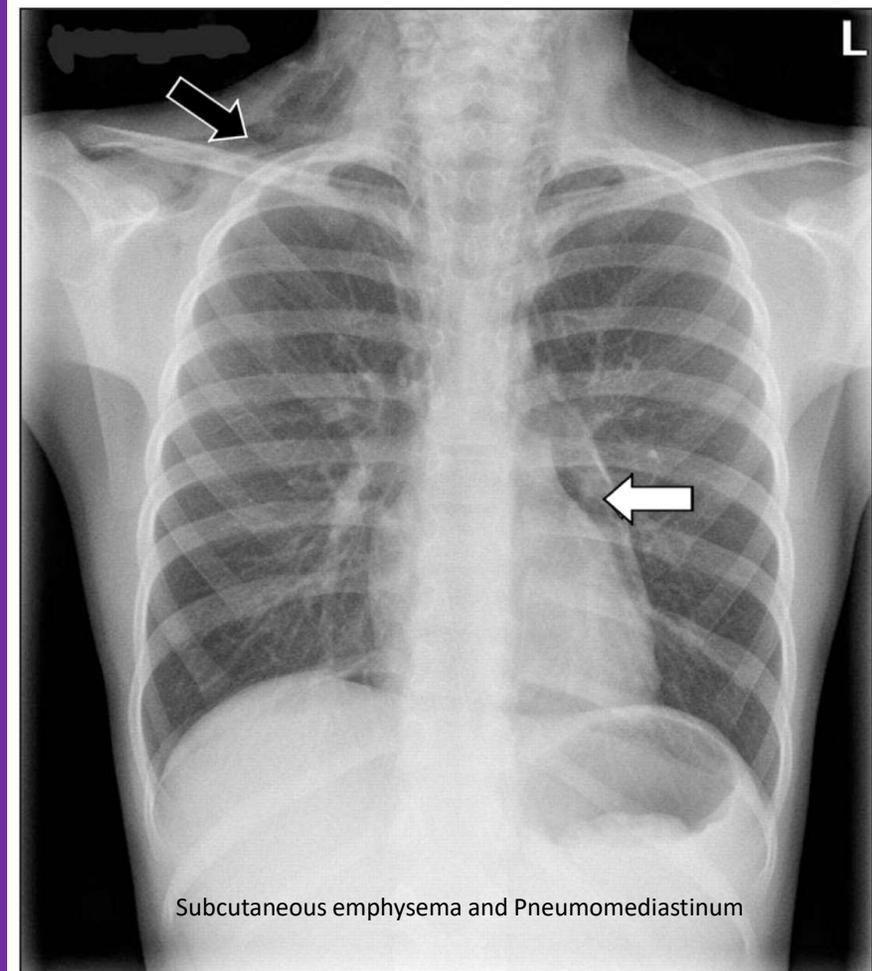


TERMINOLOGY

- Apnea - Total cessation of breathing, also known as a respiratory arrest
- Dyspnea - Difficult or labored breathing
- Bradypnea – Abnormally slow rate of respiration (<8 BPM)
- Tachypnea - Abnormally excessive, rapid rate of respirations (>20 BPM)

TERMINOLOGY

- **Hypoxia** - Insufficient concentration of O₂ in the tissue in spite of an adequate blood supply
- **Subcutaneous Emphysema** - Presence of air or a gas in the subcutaneous tissues around the face, neck, and/or the chest
 - Skin may appear swollen and makes a *CRACKLING* sound when palpated
 - Sounds and feels like *RICE CRISPIES*



TERMINOLOGY

- **Hyperventilation** - Increase in the rate and depth of respiration causing an increase in O₂ and a decrease in CO₂

- **Hypoventilation** - Loss of ventilation drive (TBI). Upper or lower airway obstruction, and decreased expansion of the lungs

RESPIRATORY ALKALOSIS **VS** **RESPIRATORY ACIDOSIS**

RESPIRATORY ALKALOSIS

- Seizures
- Deep, Rapid Breathing
- Hyperventilation
- Tachycardia
- ↓ or Normal BP
- Hypokalemia
- Numbness & Tingling of Extremities
- Lethargy & Confusion
- Light Headedness
- Nausea, Vomiting
- Causes: Hyperventilation (Anxiety, PE, Fear) Mechanical Ventilation

RESPIRATORY ACIDOSIS

- Hypoventilation → Hypoxia
- Rapid, Shallow Respirations
- ↓ BP
- Skin/Mucosa Pale to Cyanotic
- Headache
- Hyperkalemia
- Dysrhythmias (↑K⁺)
- Drowsiness, Dizziness, Disorientation
- Muscle Weakness, Hyperreflexia
- Causes: Respiratory Depression (Anesthesia, Overdose, ↑ICP) Airway Obstruction ↓ Alveolar Capillary Diffusion (Pneumonia, COPD, ARDS, PE)

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Types of Respiratory Trauma

Blunt Trauma

- Caused by severe blow, blast, crush injuries, or rapid deceleration
- May result in:
 - Pulmonary contusion
 - Flail chest
 - Cardiac tamponade

Penetrating Trauma

- Caused by gun shot, stab wounds, shrapnel, etc.
- May result in:
 - Damage to organs in path of object
 - Hemorrhage

Types of Respiratory Trauma

Blunt Trauma



Penetrating Trauma



Assessment

- Communicate with the casualty if possible
 - Likely to be experiencing chest pain, frequently the pain is worse with respiratory efforts or movement
 - Shortness of breath
 - Apprehensive or lightheaded if shock is developing
- IAP
 - Inspect (look)
 - Auscultate (listen)
 - Palpate (feel)

Inspect

- Skin
 - Pallor
 - Sweating
 - Presence of cyanosis
- Frequency of respirations
 - Rate
 - Rhythm
 - Depth
- Tracheal Deviation

Inspect

- Jugular Vein Distention
- Gasping, contractions of the accessory muscles of respiration in the neck, or nasal flaring
- Contusions, abrasions, and lacerations
- Bilateral or Unilateral breathing
- Paradoxical chest wall movement

Auscultate

- Identify differing bilateral breath sounds
 - Unilaterally decreased or absent
 - May indicate pneumothorax or hemothorax
- Pulmonary contusions may result in abnormal breath sounds (subcutaneous emphysema)

Palpate

- Gently press the chest with palms of hands to assess for the presence of tenderness, crepitus, crackling, and bony instability of the chest wall
- Place both hands on either side of the chest and assess for comparative rise and fall of the chest

Pulse Oximetry

- Pulse oximetry tells:
 - Heart rate
 - Percent of oxygenated blood (“O2 sat”)
- 98% or higher is normal at sea level
- 86% is normal at 12,000 feet due to the lower atmospheric pressure at that altitude



Pulse Oximetry

- Consider using pulse oximetry on:
 - A casualty with severe penetrating, blunt, or blast chest trauma at risk for developing a tension pneumothorax.
 - TBI- good O₂ saturation is very important for a good outcome
 - Unconscious casualty
- Oxygen saturation values as shown on pulse ox may be inaccurate in the presence of:
 - Hypothermia
 - Carbon monoxide poisoning
 - Very high ambient light levels



Rib Fracture

Signs and Symptoms

- Pain at the site with inhalation or exhalation
- Shortness of breath (SOB)
- Deformity
- Crepitus
- Bruising

Rib Fracture

Signs and Symptoms

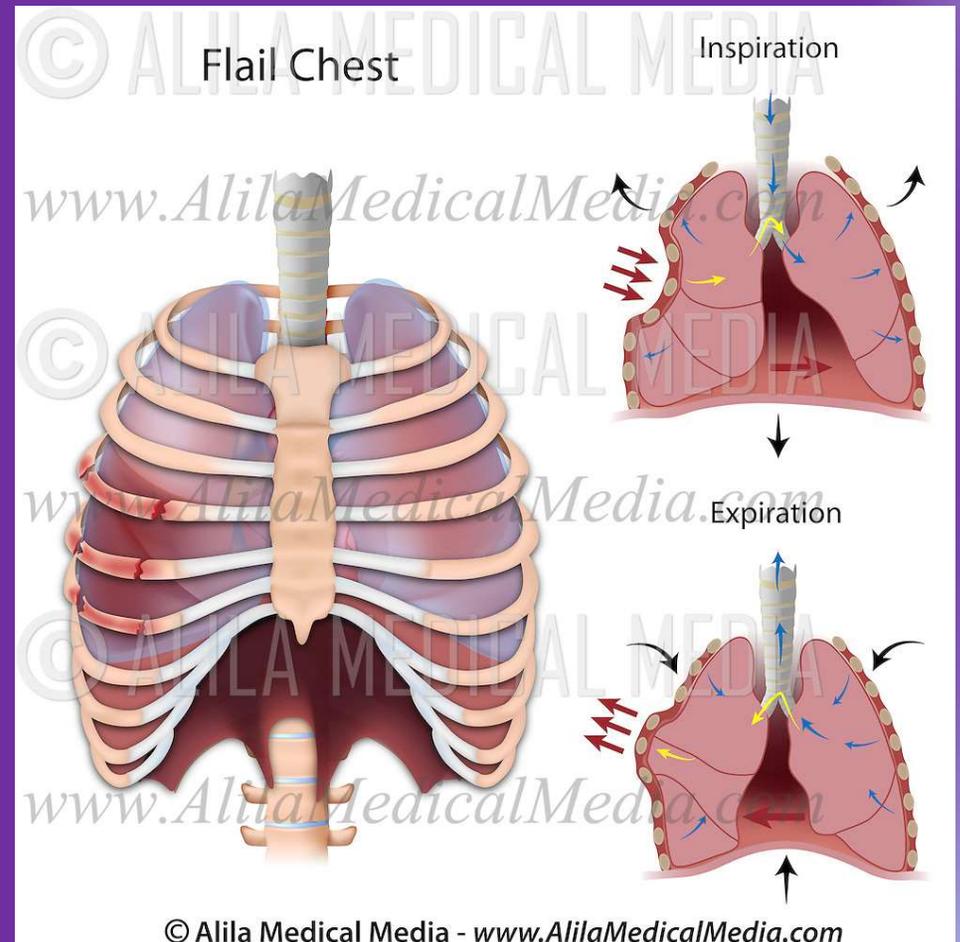
- Fractures of the first and second rib normally indicate head injury
- Simple Rib FX's
 - Usually require no tx other than analgesics
- Multiple FX's
 - Can be immobilized to the affected side using patient's arm and a sling

Rib Fracture

- May cause injuries to nearby structures
- Anticipate potential complications
 - Tension Pneumothorax
 - Soft Tissue Injury
- Encourage coughing and deep breathing to help prevent pneumonia
- Avoid bandaging or taping that encircles the chest
- Monitor and TACEVAC as necessary

Flail Chest

- A segment of 2 or more adjacent ribs fractured in at least 2 places
- The segment moves IN with inhalation and OUT with exhalation, called *Paradoxical Movement*
- Caused by blunt trauma to the chest wall



Flail Chest

SIGNS & SYMPTOMS

- Localized chest pain, aggravated by breathing and coughing
- Rapid, shallow respirations
- Tenderness or crepitus upon palpation
- Subcutaneous emphysema

Flail Chest

TREATMENT

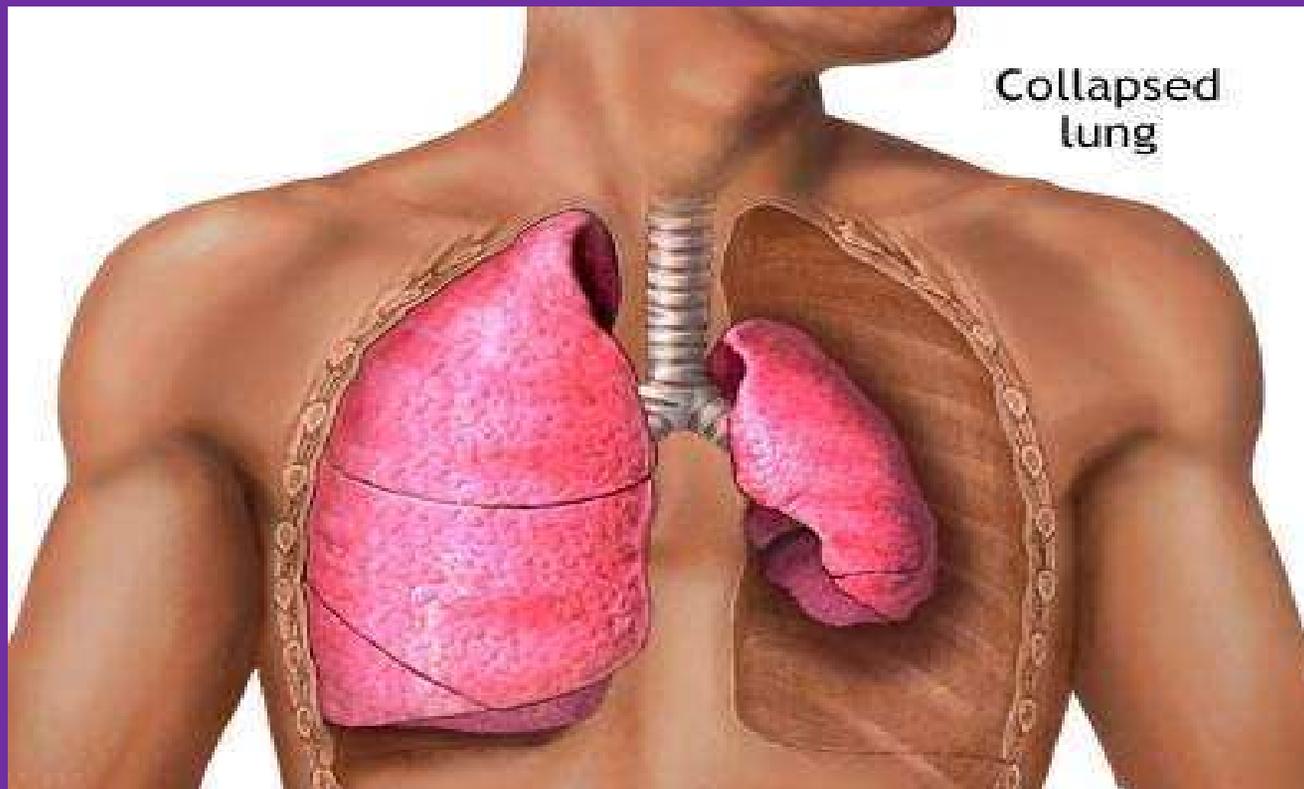
- Immobilize flail segments upon inhalation using strips of tape
- Positive pressure ventilation if you suspect respiratory failure
- Analgesics
- O2 if available
- Monitor and TACEVAC as necessary



Pneumothorax

- A pneumothorax is caused by the presence of air in the pleural space
 - The air separates the pleura causing the lungs to either partially or totally collapse
- Caused by trauma of the chest
 - Either blunt or penetrating trauma may cause a pneumothorax
 - Also possible with abdominal injuries that cross the diaphragm
 - May occur spontaneously

Pneumothorax



Pneumothorax

SIGNS / SYMPTOMS

- Pleuritic chest pain
- Tachypnea / Dyspnea
- Decreased or absent breath sounds on affected side
- Decreased chest wall motion

Pneumothorax

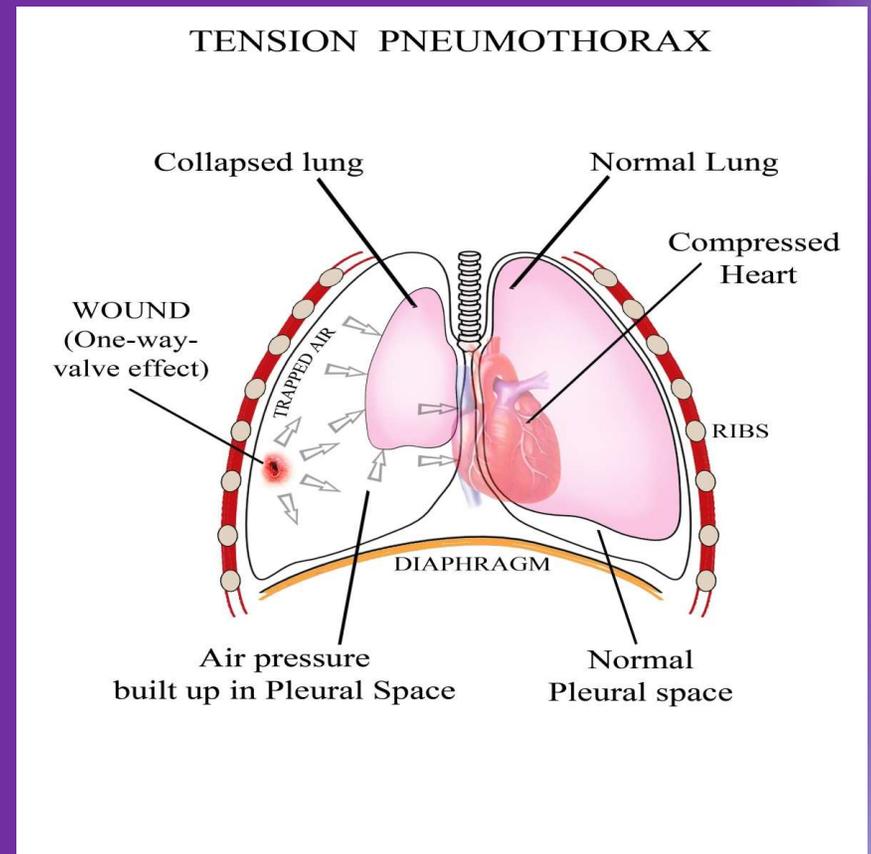
TREATMENT

- Place pt in Supine position
- Administer O2 if available
 - Use BVM if hypoxia is present
- If caused by wound, apply occlusive dressing and monitor for s/sx's of tension pneumothorax
- TACEVAC ASAP



Tension Pneumothorax

- Air enters the pleural space and cannot escape
- Pressure builds in pleural space and breathing becomes more difficult
- The lung collapses from the pressure and the mediastinum is forced to the opposite side
- Cardiac blood flow is severely decreased



Signs and Symptoms

Early S/Sx

- Unilateral decreased or absent breath sounds
- Dyspnea
- Tachypnea

Signs and Symptoms

Progressive S/Sx

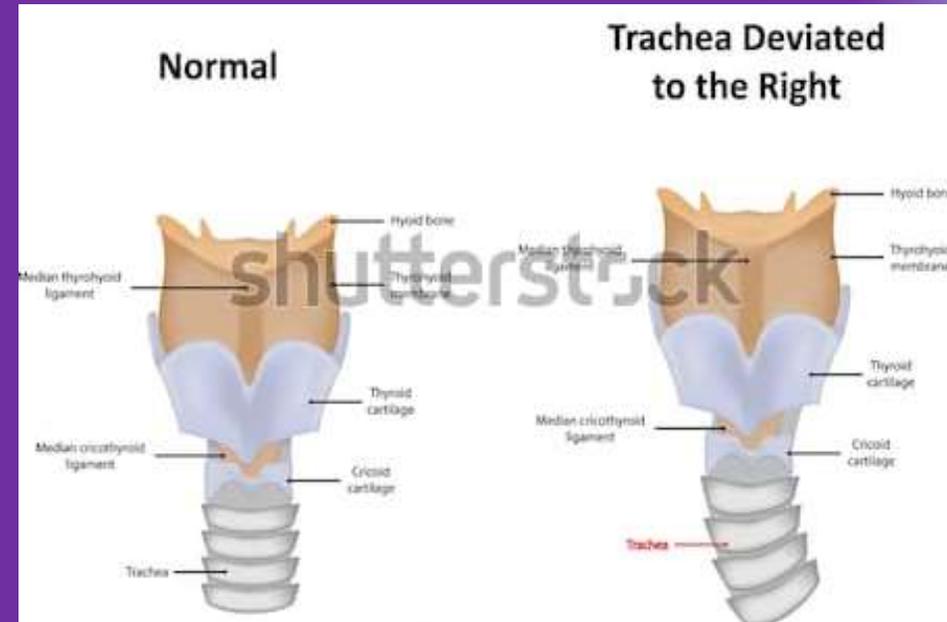
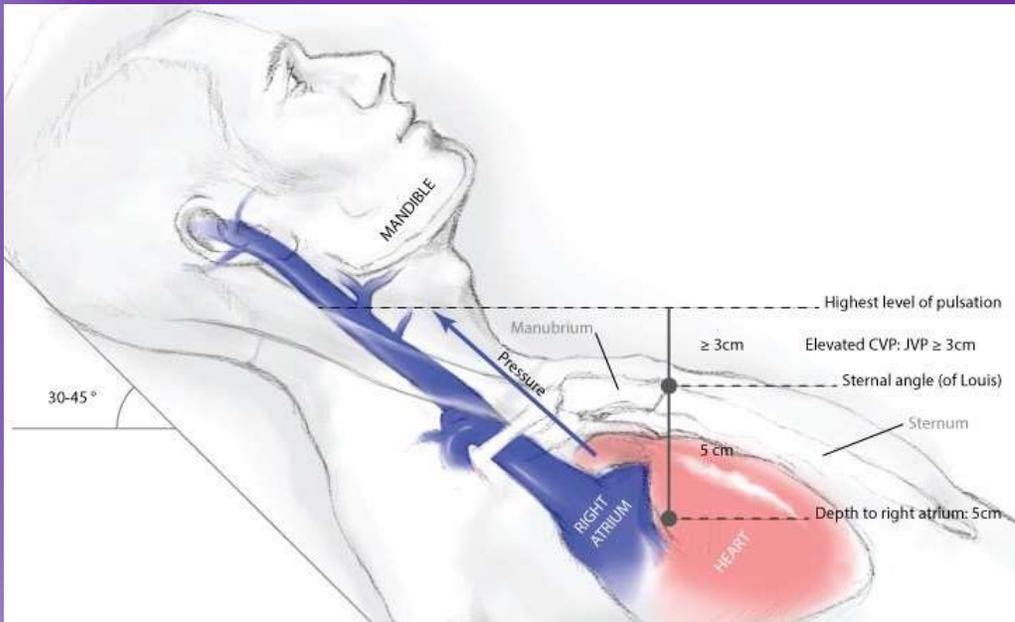
- Difficulty ventilating
- Increased dyspnea
- Increased tachypnea

Signs and Symptoms

Late S/Sx

- Jugular Vein Distention (JVD)
- Tracheal Deviation (towards unaffected side)
- Acute hypoxia
- Narrowing pulse pressures
- Uncompensated Shock

Late Stage Signs



Treatment

- Treat all chest injuries with occlusive dressing
- Perform needle thoracentesis
- Administer oxygen (if available)
- Pain management
- Monitor and TACEVAC



Open Pneumothorax

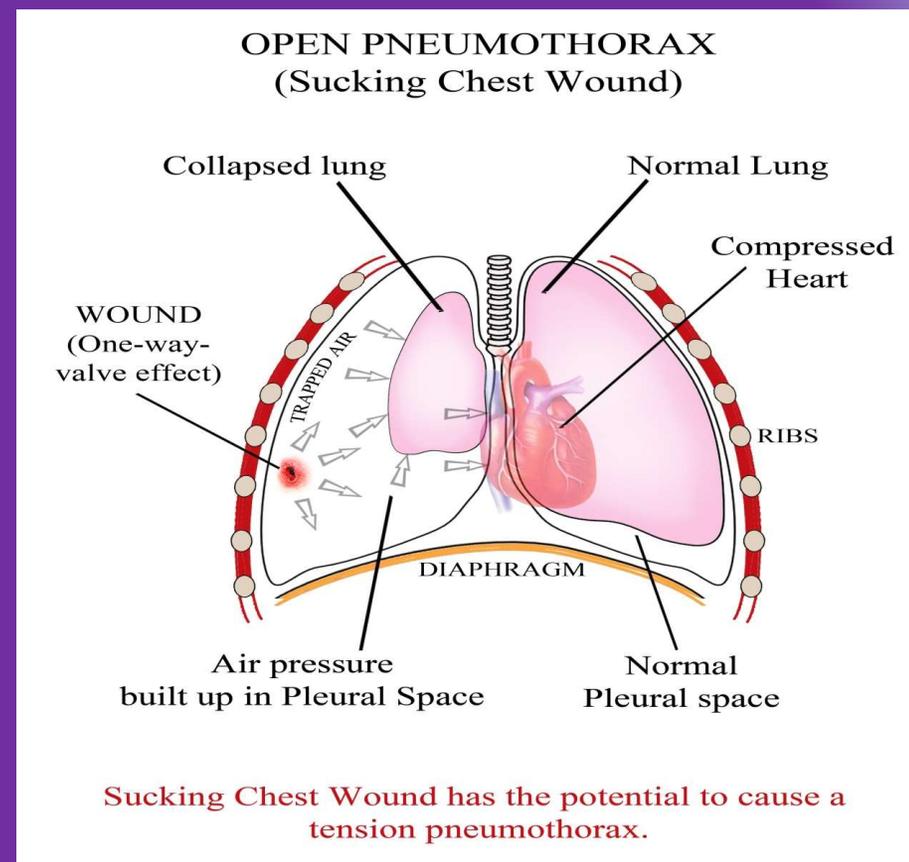
(Sucking Chest Wound)

DEFINITION

- A collection of air or gas in the pleural space that causes the lung to collapse
- More than the normal amount of air will enter the lung adding stress and tension to affected side

CAUSES

- Gunshot, stab wounds, impaled objects, occasional blunt trauma
- It takes a hole in the chest the size of a nickel or larger for this to occur.



OPEN PNEUMOTHORAX



Signs and Symptoms

- Pain at the injury site
- Chest wall trauma
- Shortness of breath
- Tachypnea
- Decreased chest wall motion
- May hear a sucking or bubbling sound as air moves through the wound



Treatment

- Assess anterior and posterior torso for entrance/exit wounds
- Occlusive Dressing to all wounds
 - Apply a vented chest seal
 - or*
 - Improvised chest seal
 - Tape on all sides
- Roll patient on AFFECTED Side

Treatment

- Monitor for signs/symptoms of tension pneumothorax
- Administer O₂, if available
- Pain management
- Monitor and TACEVAC ASAP



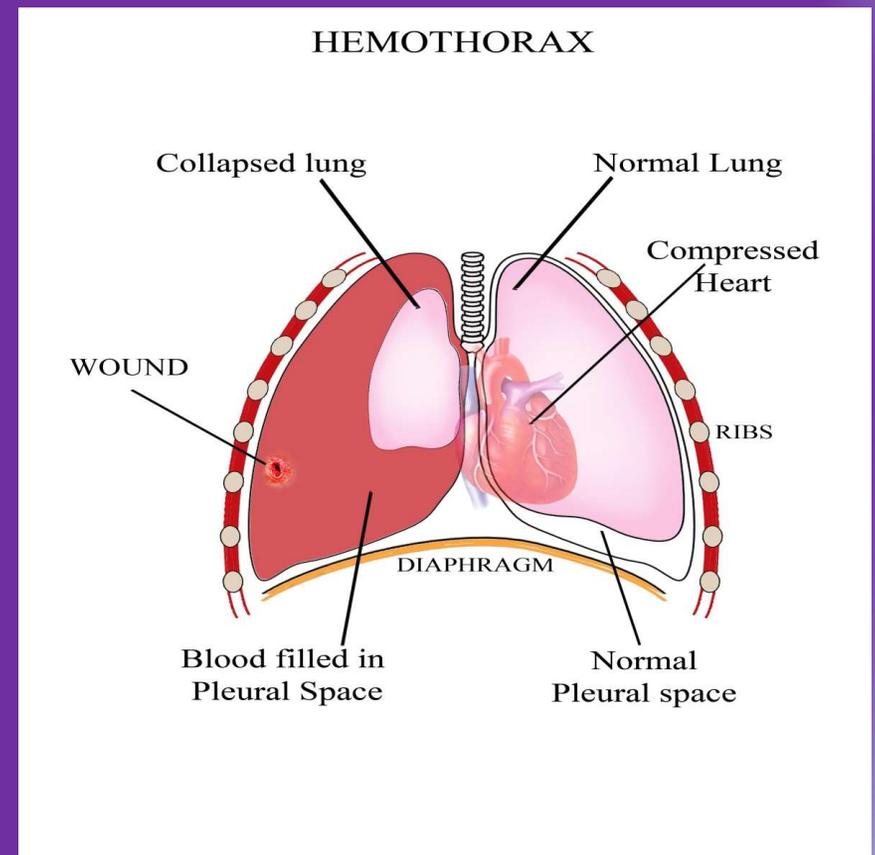
Hemothorax

DEFINITION

- Blood accumulated into the chest cavity from lacerated vessels compressing the lung
- Prevents adequate ventilation
- If air is also present, it is a hemopneumothorax

Causes

- Penetrating or blunt trauma



Hemothorax

SIGNS / SYMPTOMS

- SOB
- Chest pain
- Tachypnea
- S/S of shock: pallor, confusion, hypotension
- Decreased or absent breath sounds
- Hemoptysis (coughing up blood)
- Decreased chest wall motion

Hemothorax

TREATMENT

- Place patient In
- Supine or Recovery Position
- Perform needle thoracentesis to relieve pressure
 - If blood is withdrawn, immediately remove needle and catheter
- Administer O2, if available
- Treat for shock
- Monitor and TACEVAC

Comparison

Open Pneumothorax

Open wound allows air to flow into chest cavity

Requires Vented Chest Seal

“Becomes”
Tension Pneumo. once wound is sealed

Needle decompression ineffective due to open wound.

Tension Pneumothorax

Closed wound causes air to build up and collapses lung(s)

Needle decompression effective due to pressure difference between plural space and outside of body.

Hemothorax/ Hemopneumo.

Same principles apply as Pneumothorax but blood (or blood and air) is causing the lung to collapse.

Needle decompression not advised.



Bolin Chest Seal

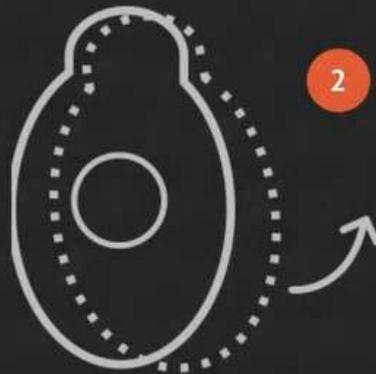
- The Bolin Chest Seal is a sterile, occlusive wound dressing specifically engineered to treat sucking chest wounds that result from gunshots, stab wounds, or other penetrating chest trauma.
- It is a ‘failure-proof’ triple-valve design that allows air and blood to escape while preventing the re-entry of either
- The wound side of the disc is covered with a thick layer of jell-based adhesive, strong enough to not only seal over hair and blood but also flexible enough to be removed and reapplied to the trauma site if required.

Bolin Chest Seal

HOW IT WORKS



Clean and dry wound.



Remove one product from release liner.



Apply vented seal to wound adhesive side down.



Apply light pressure to assure adhesion.

H & H Wound Seal Kit

- Provides a fast application for sealing wounds quickly to stop external bleeding.
- It does not have a valve to allow for air to escape the pleural space and thus may need to be 'burped' if symptoms worsen

Chest Seals

- Bolin Chest Seal (vented)
 - For entrance wound

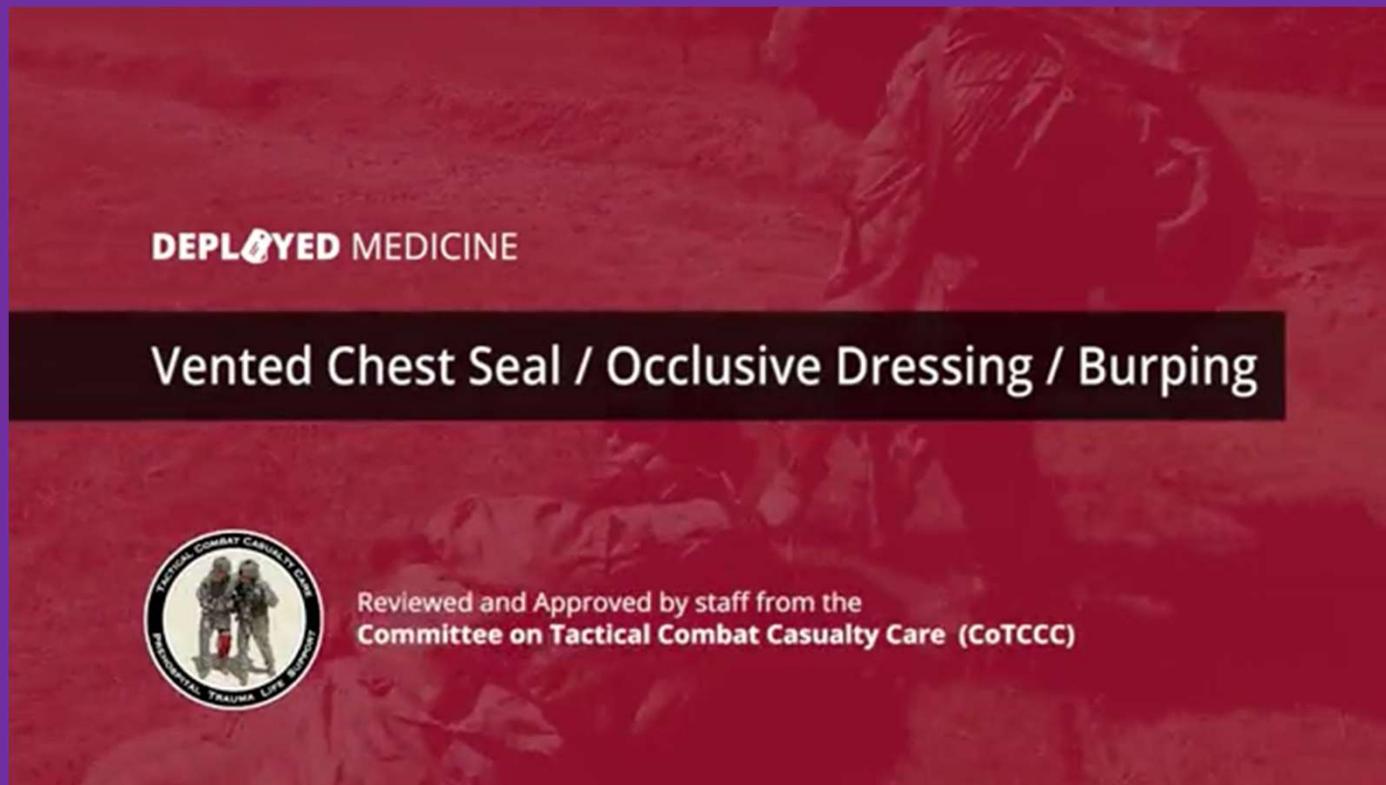
- H & H Wound Seal
 - For exit wound



Post Application

- After application, monitor for signs and symptoms of Tension Pneumothorax.
- If the casualty develops increasing hypoxia, respiratory distress, or hypotension and a tension pneumothorax is suspected, treat by burping, removing the dressing, or by needle decompression
- Positive pressure ventilation (if available) should be considered if not already employed.

Sucking Chest Wound Treatment Video



[Video on Deployed Medicine Link](#)

[Video on YouTube Link](#)



Needle Thoracentesis

Definition

- Procedure where a needle and catheter is inserted through the chest wall into the pleural space

Purpose

- Relieves accumulated pressure in the pleural space
- Reduces pressure on the heart, lungs, and chest cavity

Needle Thoracentesis Sites

Two acceptable sites:

- Lateral site

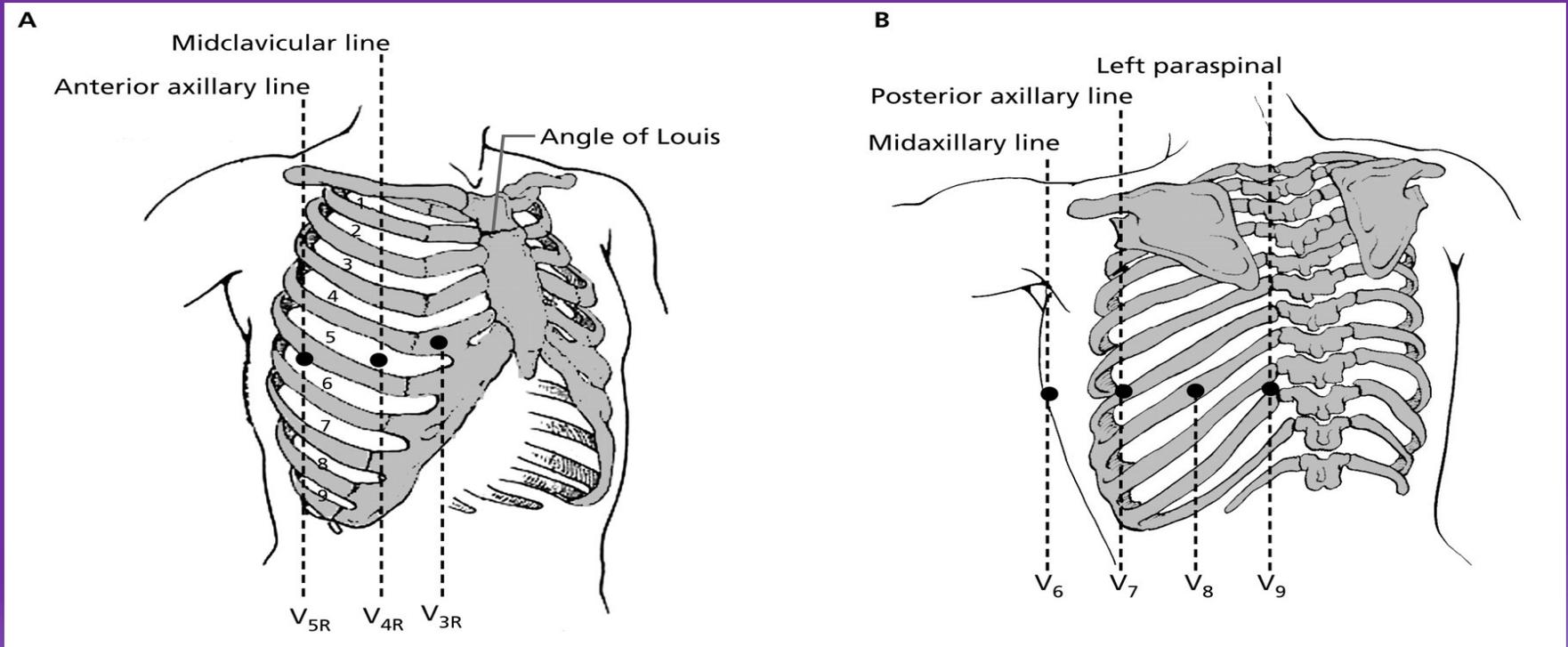
- The 5th intercostal space (ICS) in the anterior axillary line (AAL)

or

- Anterior site

- The 2nd ICS in the mid-clavicular line (MCL)

Needle Thoracentesis Sites



Lateral Site



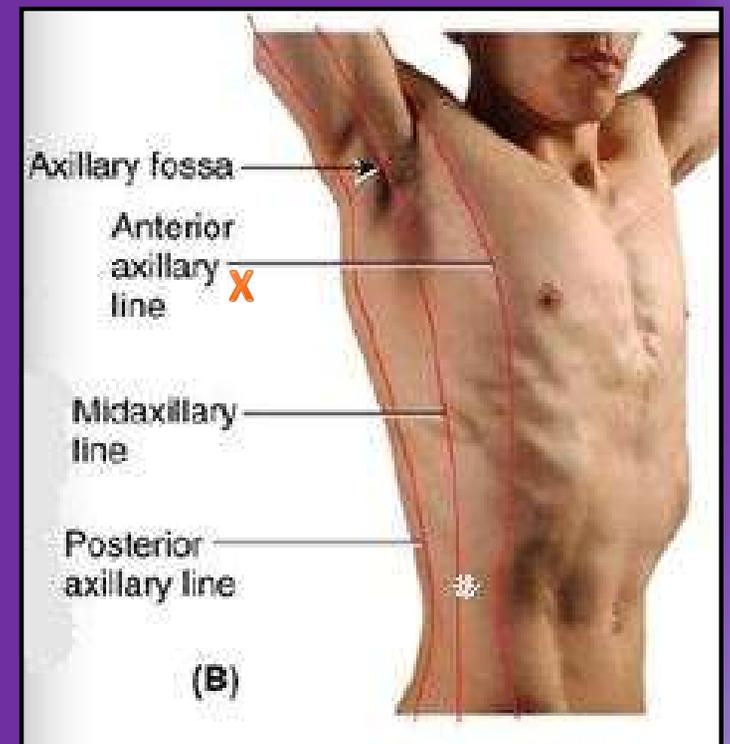
*Photo
Courtesy
Maj Andrew
Hall*



This photo shows NDC being performed at the lateral site in a cadaver model.

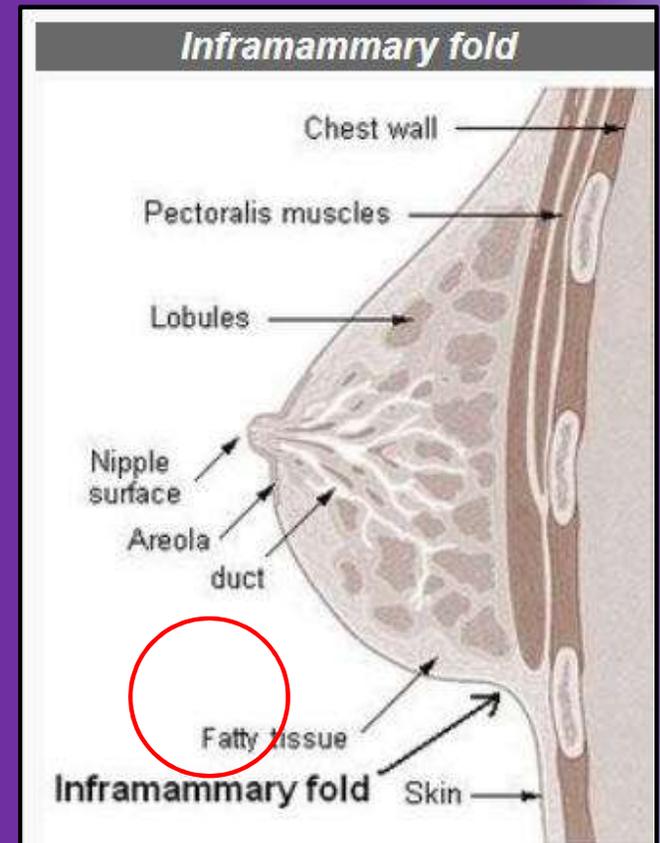
Lateral Site for Males

- The first site that can be used for NDC is the 5th intercostal space at the anterior axillary line
- The 5th intercostal space is located at the level of the nipple in young, fit males
- The AAL is located at approximately the lateral aspect of the pectoralis major muscle
- Easily located in males
 - ***Remember:** Whilst the nipple line is a more viable landmark on males, bodies vary from person to person so don't just assume it will work for everyone!



Lateral Site for Females

- Nipple level is variable in females – but you can lift the breast and use the level of the infra-mammary fold.
- Measure four fingers down from the axilla (measure the width of your hand placed under the patient's axilla with their arm down) at the lateral aspect of the breast/pectoral muscle.
- Another option - two finger breadths below the bottom of the axillary hairline.

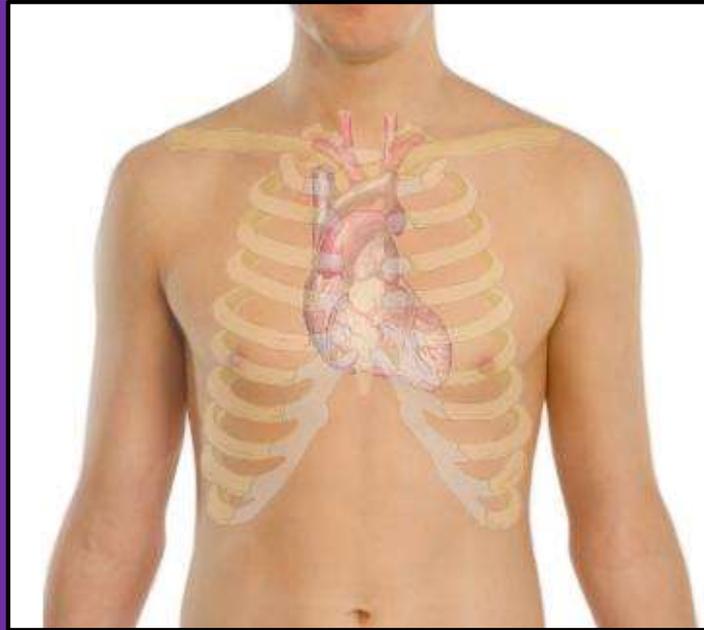


Anterior Site

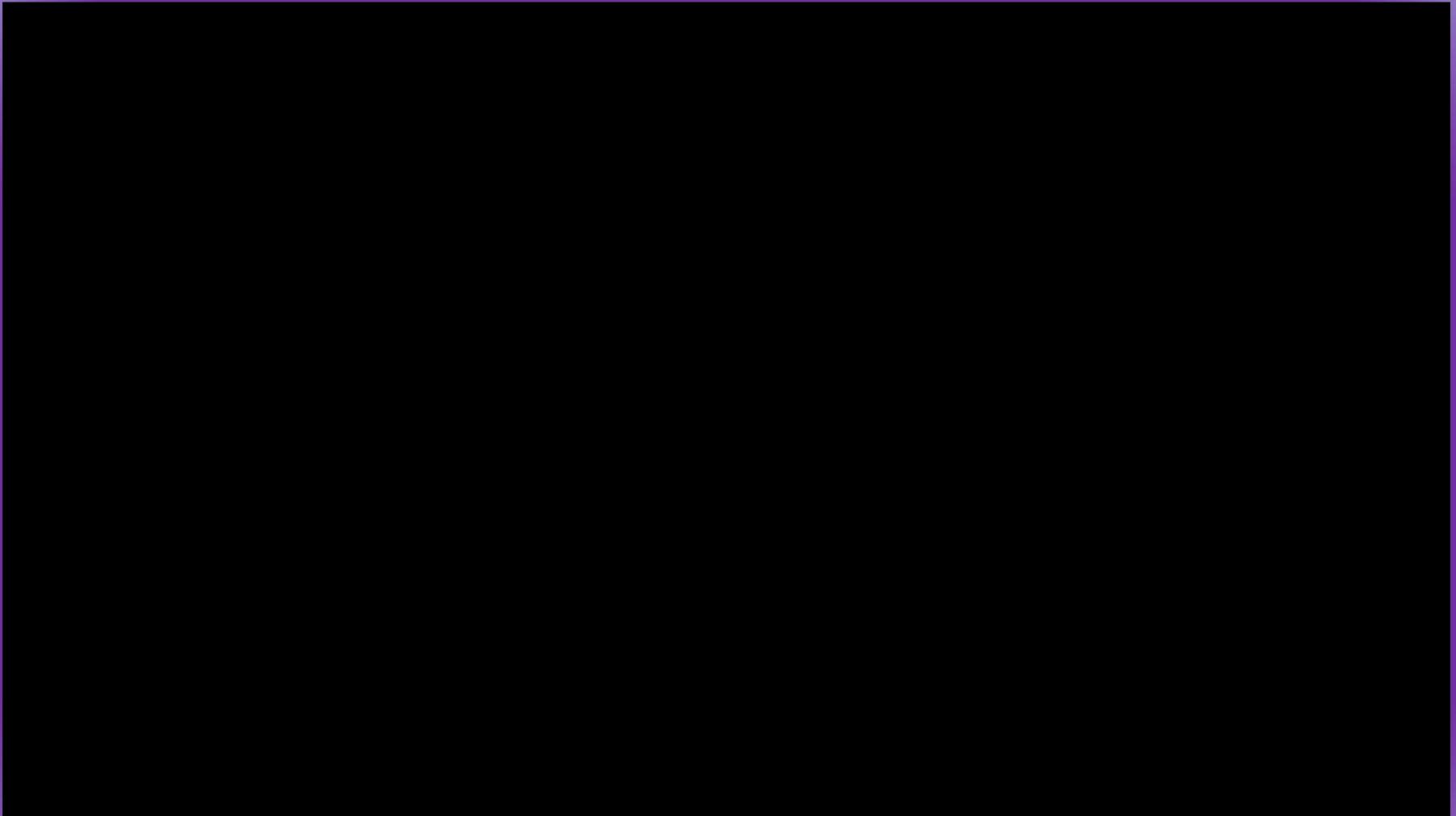


This photo shows the catheter at the anterior site after the needle was removed.

CAUTION!



- At the anterior site, the heart and great vessels are nearby.
- **Never** insert the needle medial to the nipple line.
- **Do not** point the needle towards the heart.



[Video on Deployed Medicine Link](#)

[Video on YouTube Link](#)



Indications

- Any casualty with thoracic injury is at risk for developing a tension pneumothorax.
- Casualties at particular risk are those who have a penetrating wound to the chest and those with signs of rib fracture.
- There are no significant contraindications for needle thoracentesis with penetrating chest trauma

Equipment

- 14-gauge or 10-gauge, 3.25 inch needle catheter
- Antiseptic solution
- Gloves

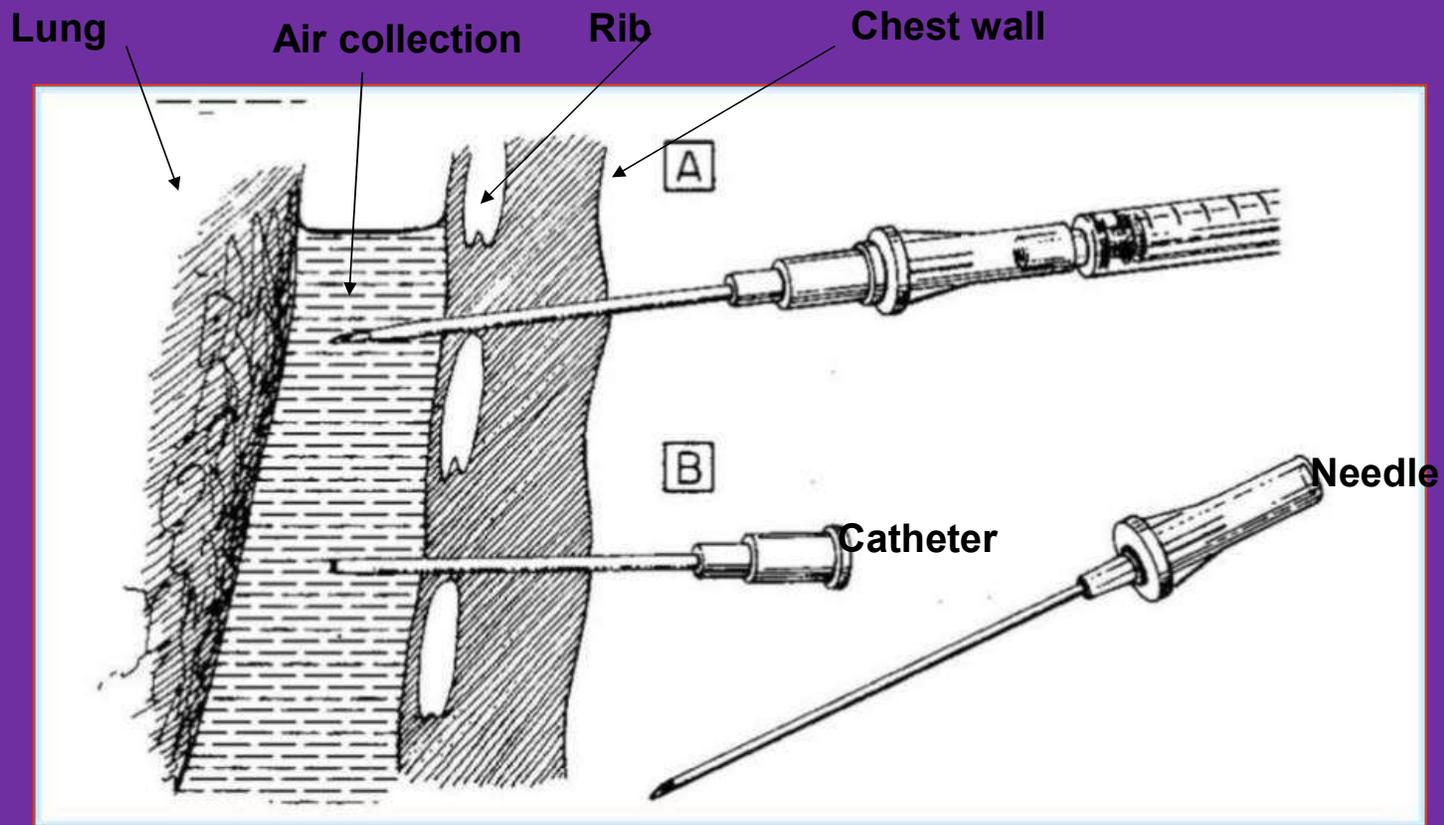
Procedure

1. Assess the casualty and make decision
 - IAP the chest
2. Assemble and check equipment
 - Make sure there are no burs or bends in the catheter and needle
3. Prepare the Patient
 - Determine site to use
 - Identify landmarks
 - Cleanse Site

Procedure

4. Insert the needle/catheter unit perpendicular (90-degree angle) to the chest wall
 - Ensure entry is over the top of the lower rib at the insertion site to avoid hitting the intercostal neurovascular bundle
 - Ensure entry is not medial to mid clavicular or angled towards the mediastinum
5. Insert the needle/catheter unit all the way to the hub
 - Hold both in place for 5-10 seconds to allow full decompression to occur before removing the needle and leaving the catheter in place.

Angle and Placement of Entry



This avoids the artery and vein at the bottom of the rib above.

Procedure

6. Verify Viability

- IAP the chest
 - **Look** for improved rise of the chest on the affected side and bilateral comparison
 - **Listen** for improved breath sounds and escaping air from the catheter
 - Place both hands on either side of the chest and **Feel** for improved rise of the chest on the affected side and bilateral comparison

7. Secure catheter to the chest with tape

Successful Needle Thoracentesis

- Respiratory distress improves
- There is an obvious hissing sound as air escapes from the chest when NDC is performed
- Hemoglobin oxygen saturation increases to 90% or greater (note that this may take several minutes and may not happen at altitude)
- A casualty with no vital signs has return of consciousness and/or radial pulse.

Unsuccessful Needle Thoracentesis

1st Attempt Fails

- Verify that initial NDC is placed on the correct side of the chest and in proper relation to the landmarks. If incorrectly placed, place another NDC but don't fuck up this time
- Perform a second NDC - on the same side of the chest - at whichever of the two recommended sites was **not** previously used. Use a new needle/catheter unit for the second attempt.

2nd Attempt Fails

- Verify that NDCs were placed correctly in relation to the landmarks. If incorrectly placed, place another NDC but don't fuck up this time
- If the NDCs are placed correctly and still not successful, continue to the Circulation section of the TCCC Guidelines.

PT Requires Multiple NDC's

- If the initial NDC was successful, but symptoms later recur:
 - Perform another NDC at the same site that was used previously. Use a new needle/catheter unit for the repeat NDC.
 - Continue to re-assess!

Complications

Hemothorax

- Blood within the pleural space
- Caused by needle puncturing any vessel within the chest

Cardiac Tamponade

- Pressure on the heart that occurs when blood or fluid builds up in the space between the heart muscle and the pericardium.
- Ensure needle is at or lateral to the nipple line

Subcutaneous Emphysema

- Released air becomes trapped under skin
- Feels like “rice crispies”

Needle Thoracentesis



*Video courtesy of Dr. Oleksandr Linchevskyy
Medical Director, Patriot Defence
Ukraine*



Discussion Question

“What if the casualty does not have a tension pneumothorax when you do your needle decompression?”

Answer

- If they have penetrating trauma to that side of the chest, there is probably already a collapsed lung and blood in the chest cavity
- The needle/catheter won't make it worse if there is no tension pneumothorax
- If they DO have a tension pneumothorax, you will save their life

Discussion Questions

1. What is wrong with the circled catheters?
2. What is a potential consequence of the circled catheters?
3. Why were multiple needle thoracentesis' performed?



*Photo:
Dr. Warren Dorlac*

Answer

1. The two needles circled are too medial
2. Damage to the mediastinum can result in
 - Cardiac Tamponade
 - Damage to the phrenic nerve (diaphragmatic paralysis/dysfunction)
 - Hemorrhage from the major vessels
 - And much more
3. Improper placement, occluded catheters, no improvement of Sx

Discussion Point

If a casualty has significant torso trauma or primary blast injury and is in traumatic cardiac arrest (no pulse, no respirations, no response to painful stimuli, no other signs of life), decompress both sides of the chest before discontinuing treatment.



Demonstration



Practical Application



Manage Respiratory Trauma